



# **How North American Window Performance Evaluations Affect Glass Design**

**Jim Larsen**

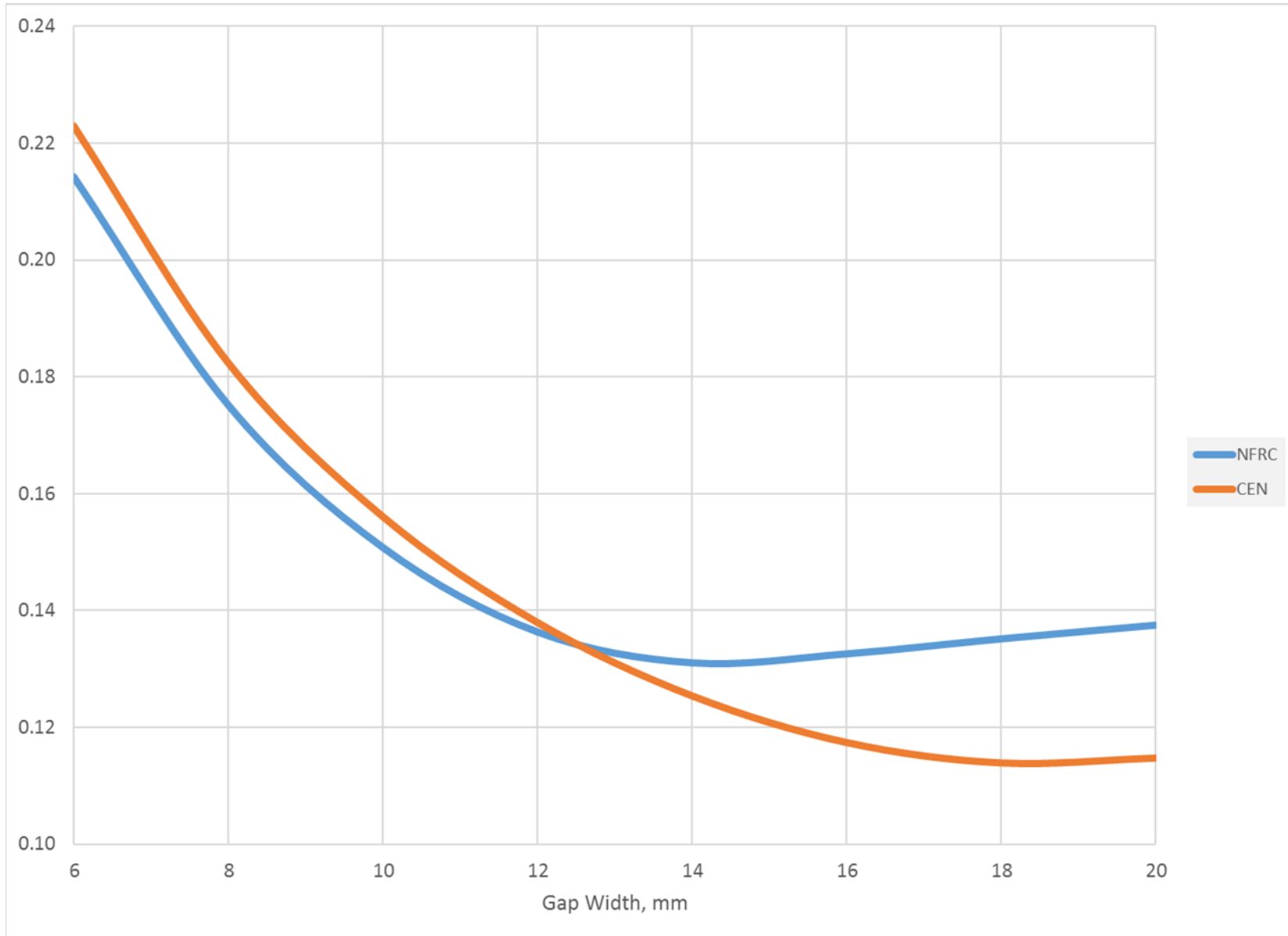
**Director, Technology Marketing**

**September 23, 2016**

# Chevy Bolt EV has Longer Range in Europe



# Triple Glass has Lower U in Europe



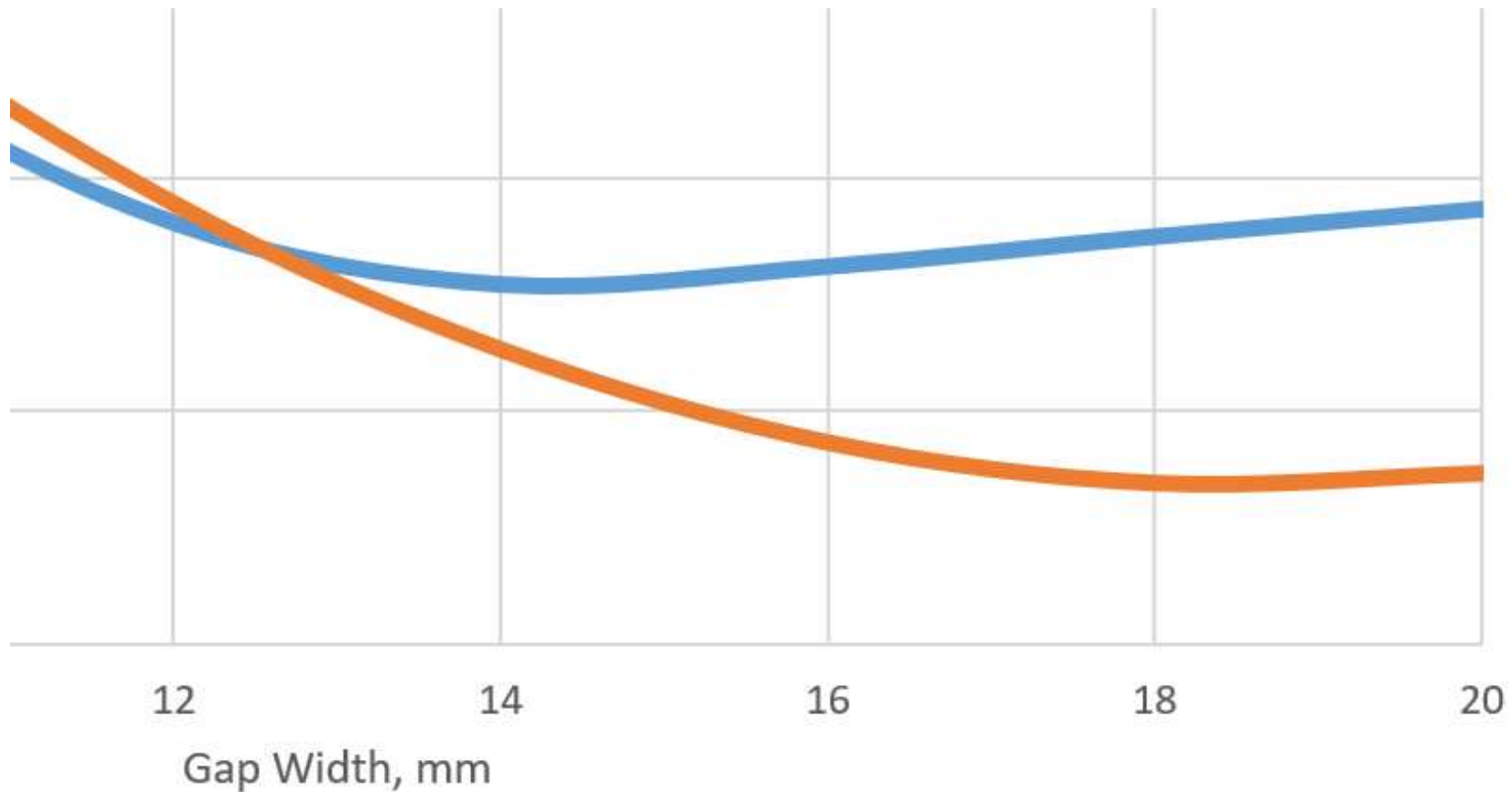
# Different Conditions = Different Ratings

---

- European Driving Cycle vs. EPA Protocol
- NFRC/ASHRAE weather vs. CEN weather

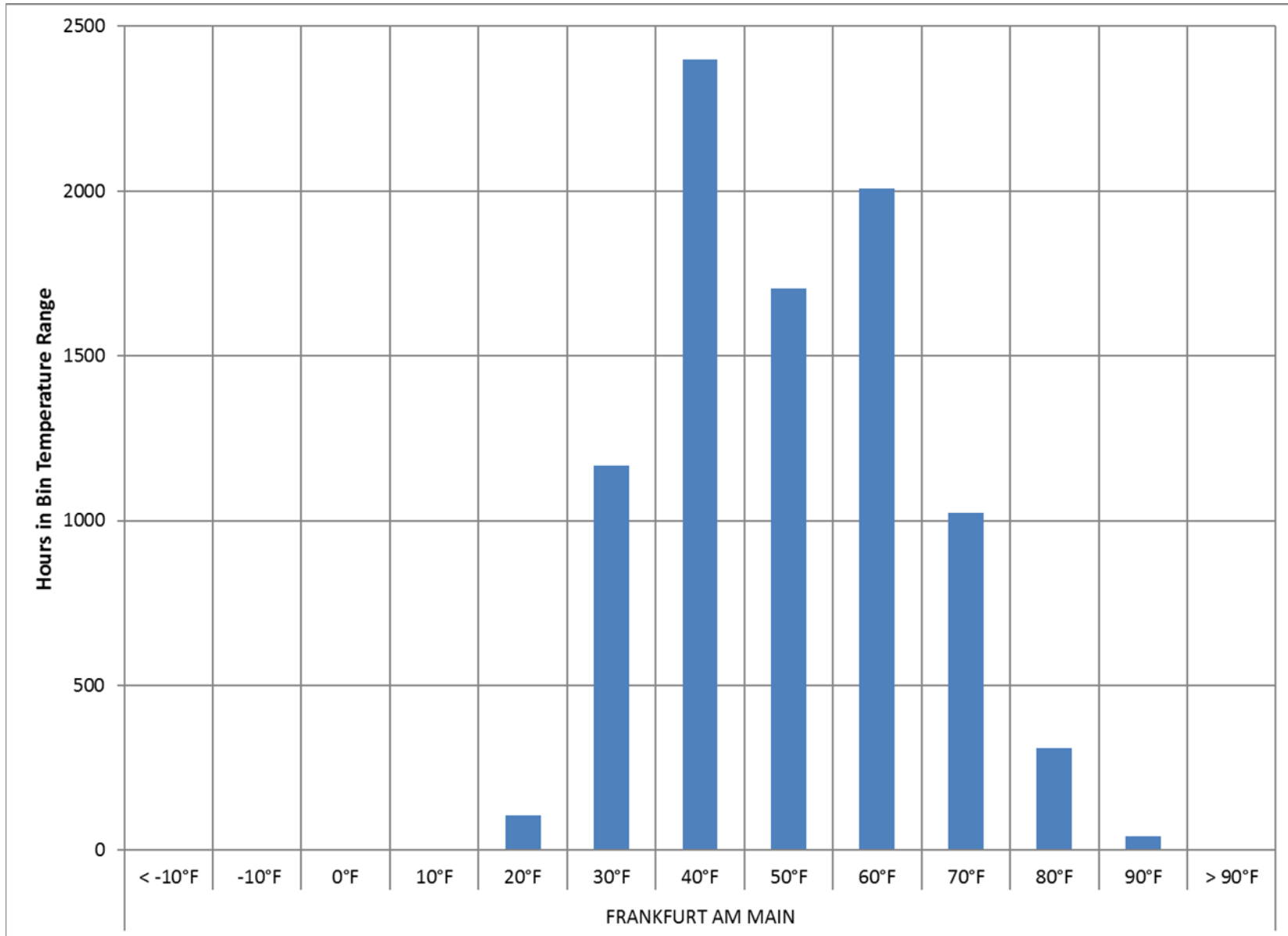


# $\Delta T$ Drives Convection in Gap

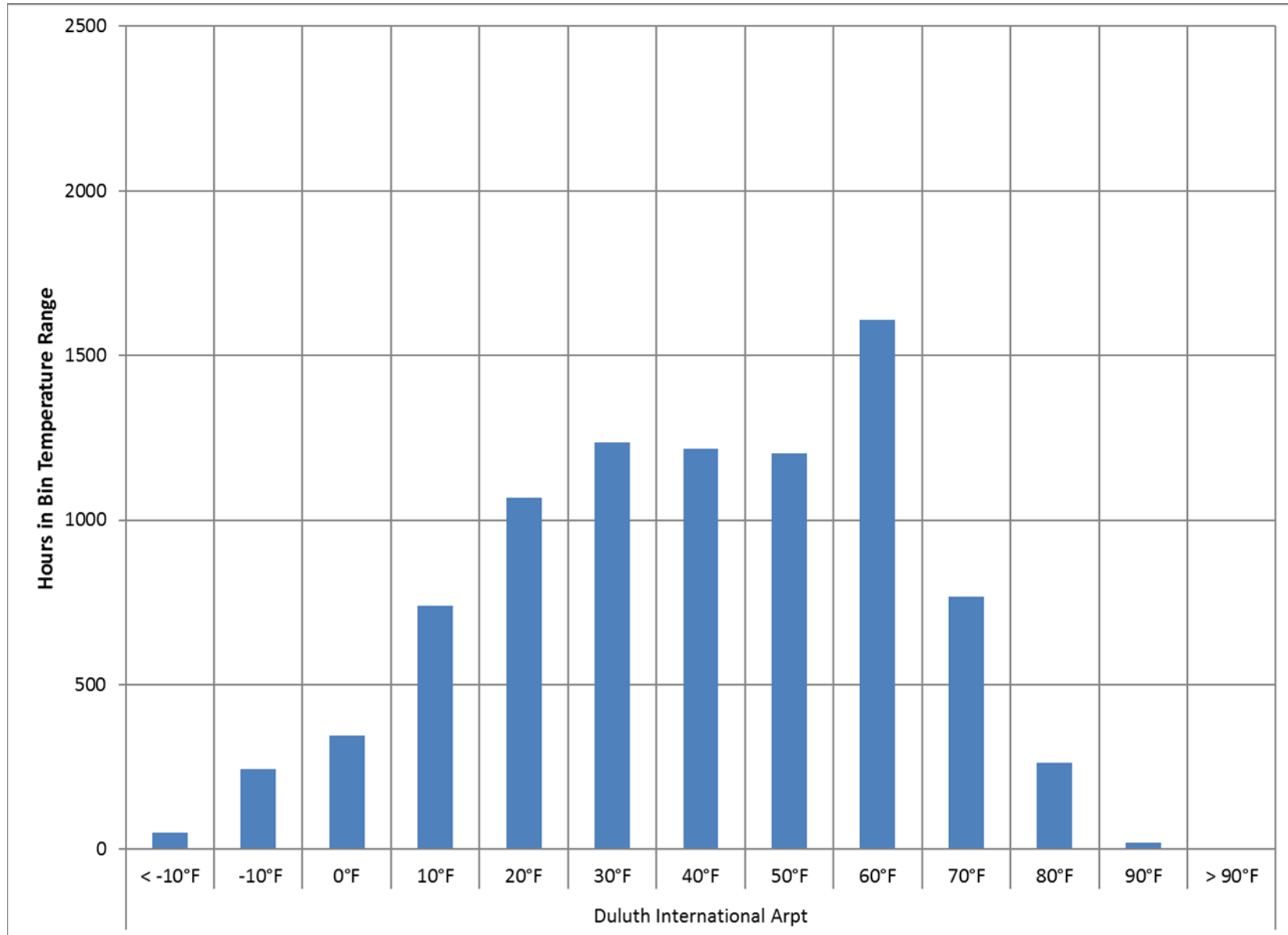


- NFRC/ASHRAE  $\Delta = 70 \text{ in} - 0 \text{ out} = 70^\circ\text{F}$
- CEN  $\Delta = 68 \text{ in} - 32 \text{ out} = 36^\circ\text{F}$

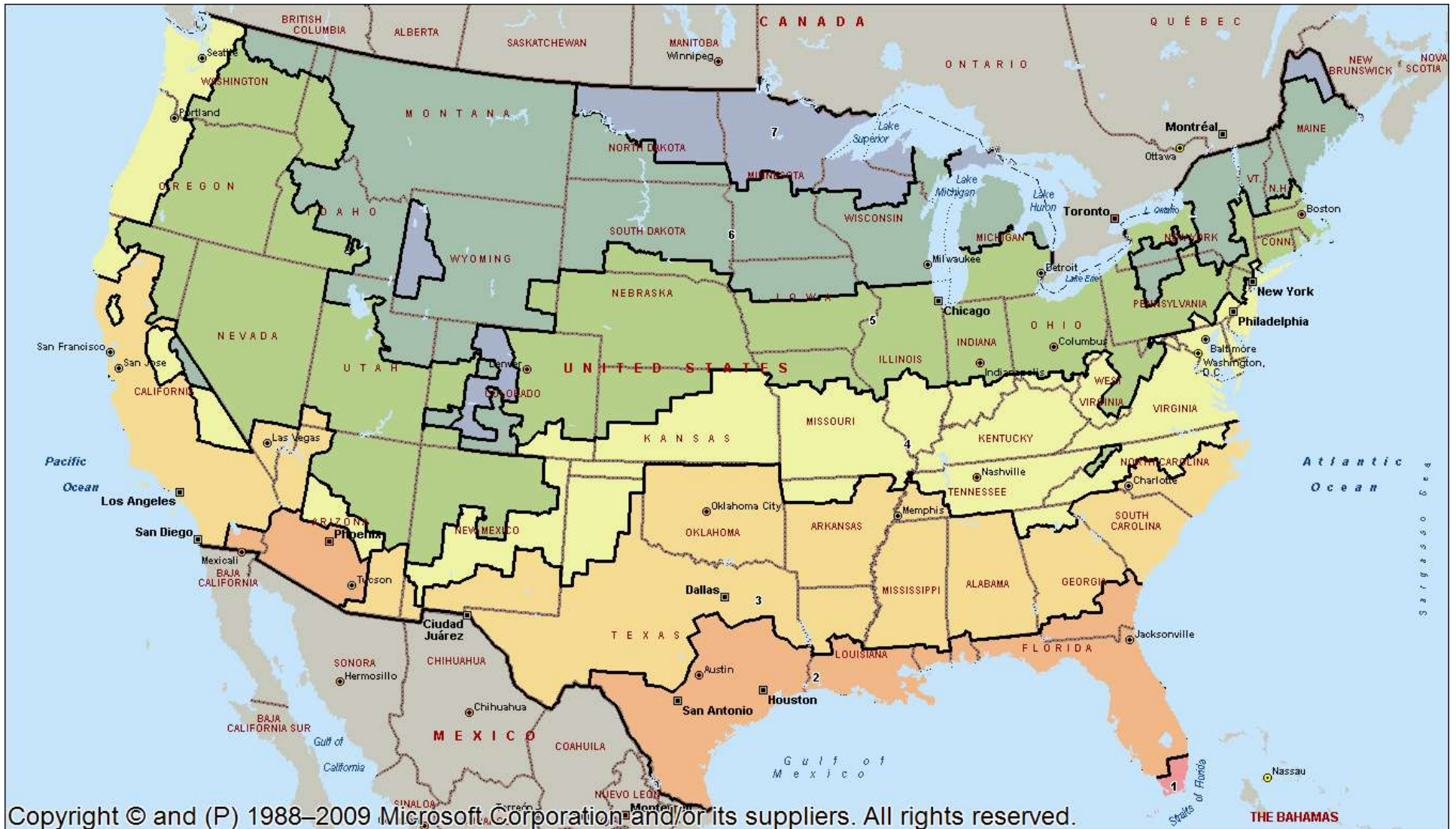
# Frankfurt Annual Temperatures



# Duluth MN Annual Temperatures

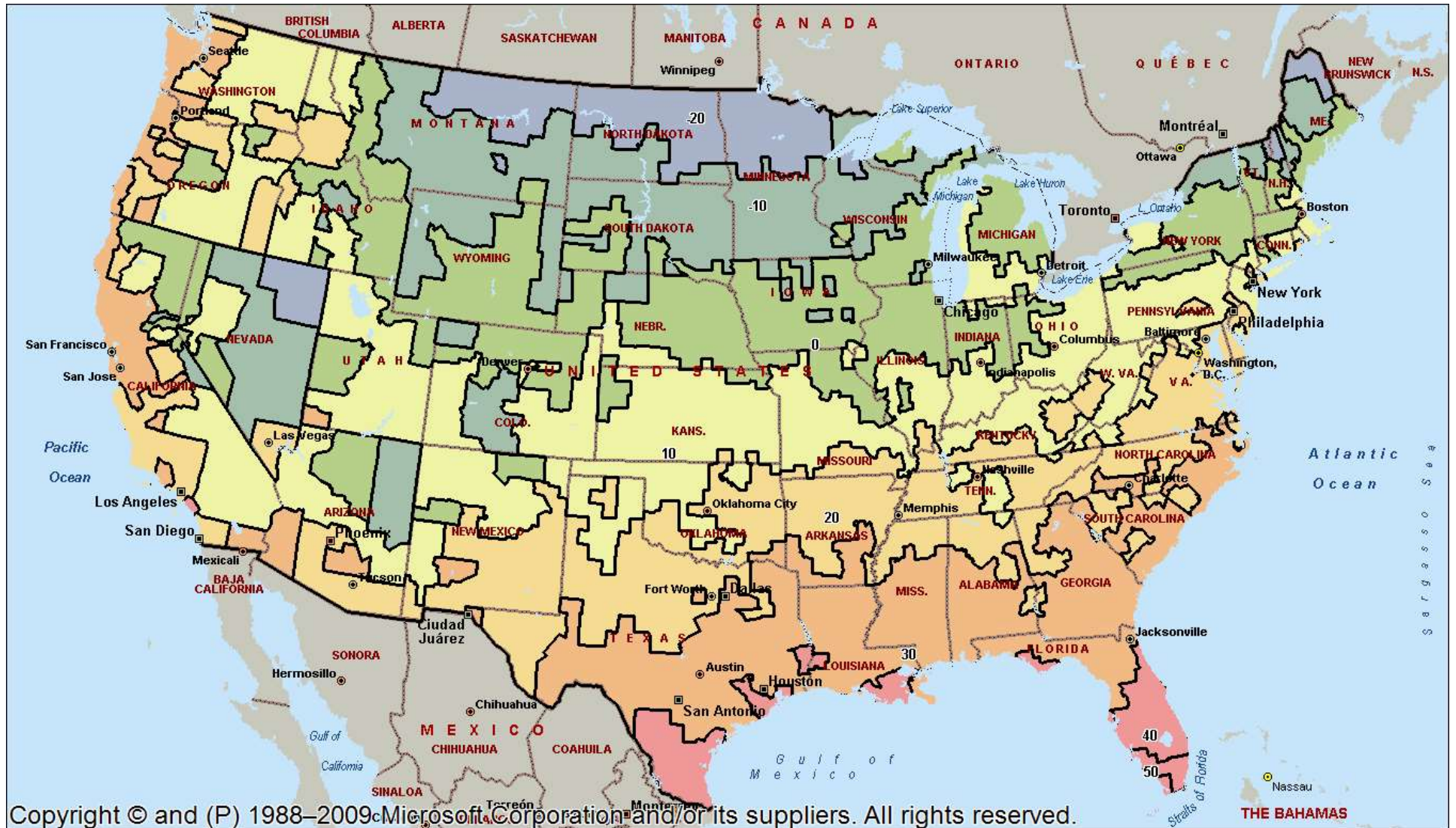


# U.S. Climate Zones

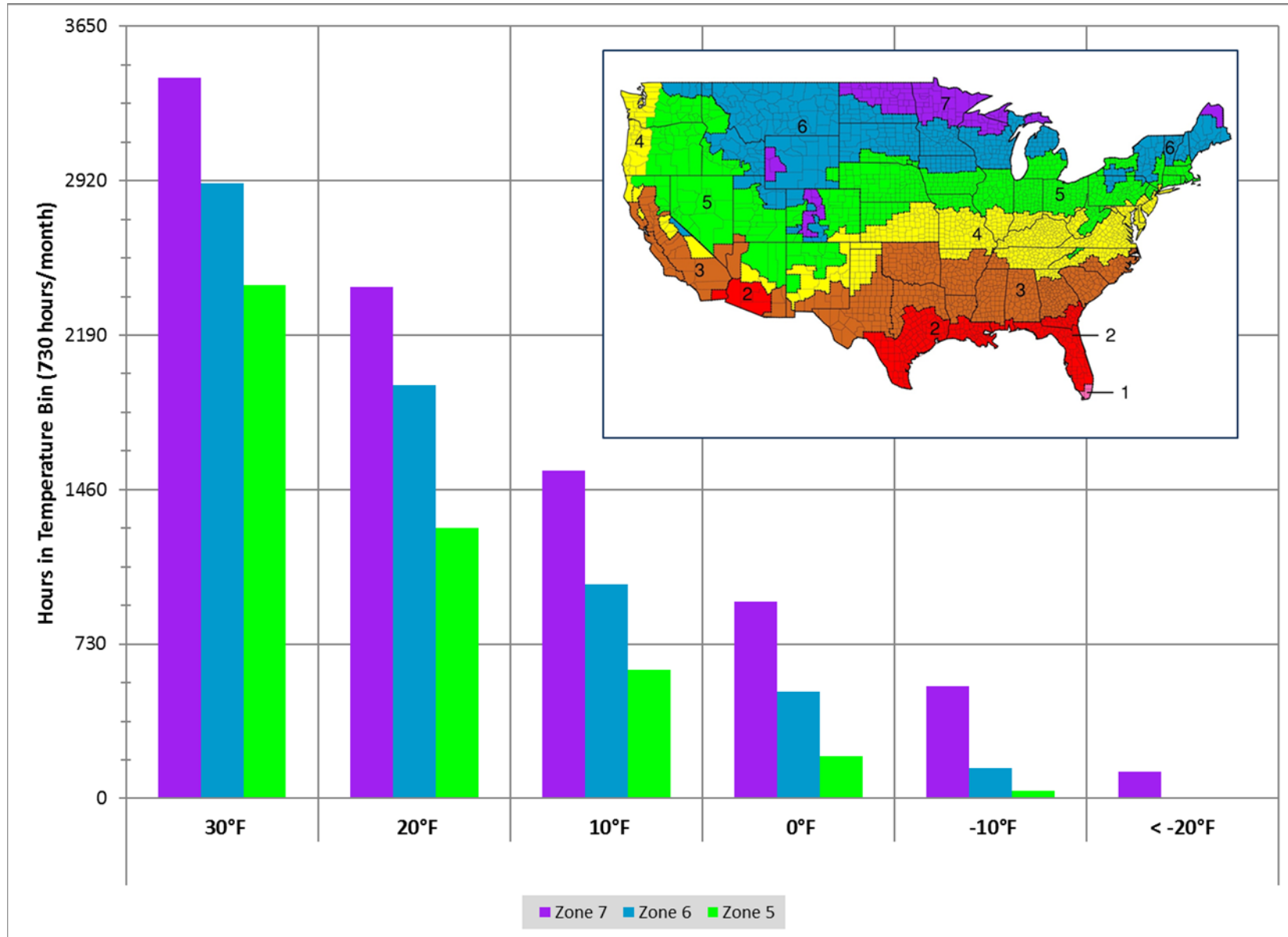




# U.S. Heating Design Temperatures



# About 2/3 U.S. is Colder than Frankfurt



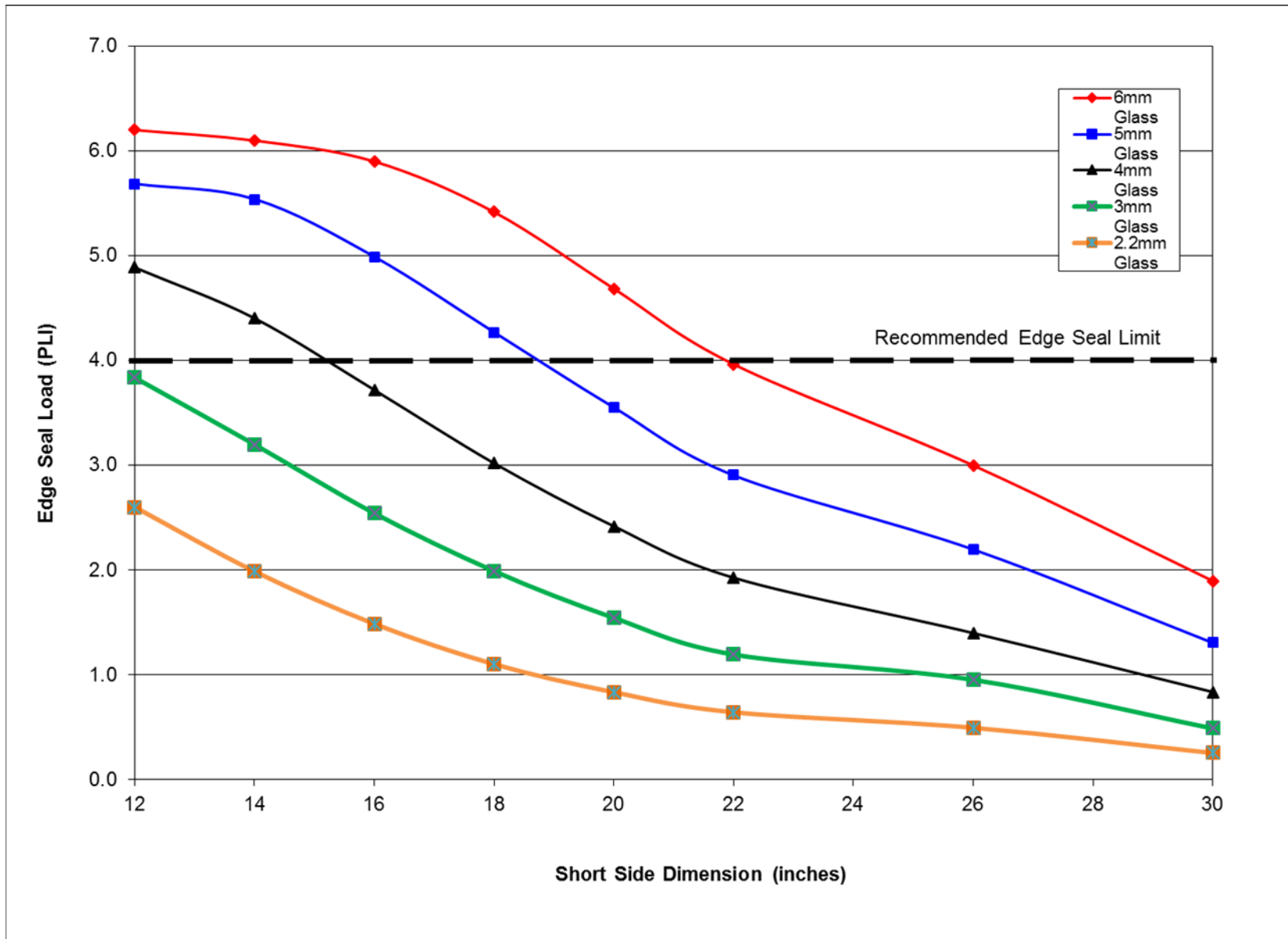
# What's this mean for triple/quad glass?

---

- Volume(s) of gas act together
  - (2) 13mm gaps = 26 mm of volume
  - More expansion/contraction
  - Stress on edge seal
  - Depending on glass size/type Cardinal recommends max gap of 13mm



# Narrow Glass can be Stress Problem



# What's this mean for triple/quad glass?

---



- Volume(s) of gas act together
  - (2) 13mm gaps = 26 mm of volume
  - More expansion/contraction
  - Stress on edge seal
  - Depending on glass size/type Cardinal recommends max gap of 13mm
- **Distortion due to differential deflections**
  - Cardinal recommends pressure equalization

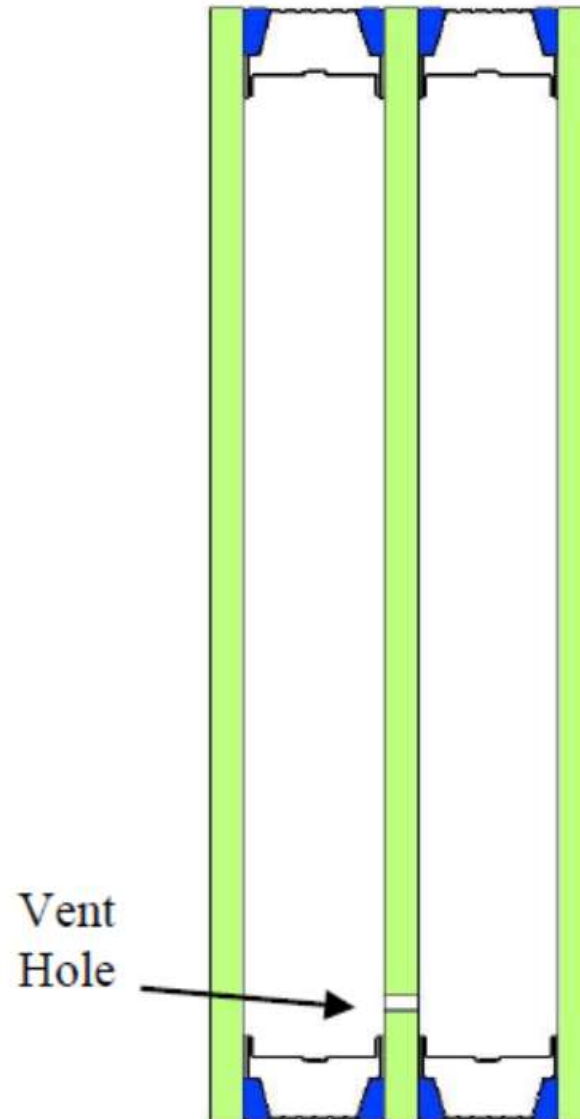
# Vented Center Pane

Cavities are at different temperatures.

Glass will deflect differently without center vent.

Potential for visible distortion.

- Small diameter (1.5mm)
- “Clean drill w/laser (no spall)



# What's this mean for triple/quad glass?

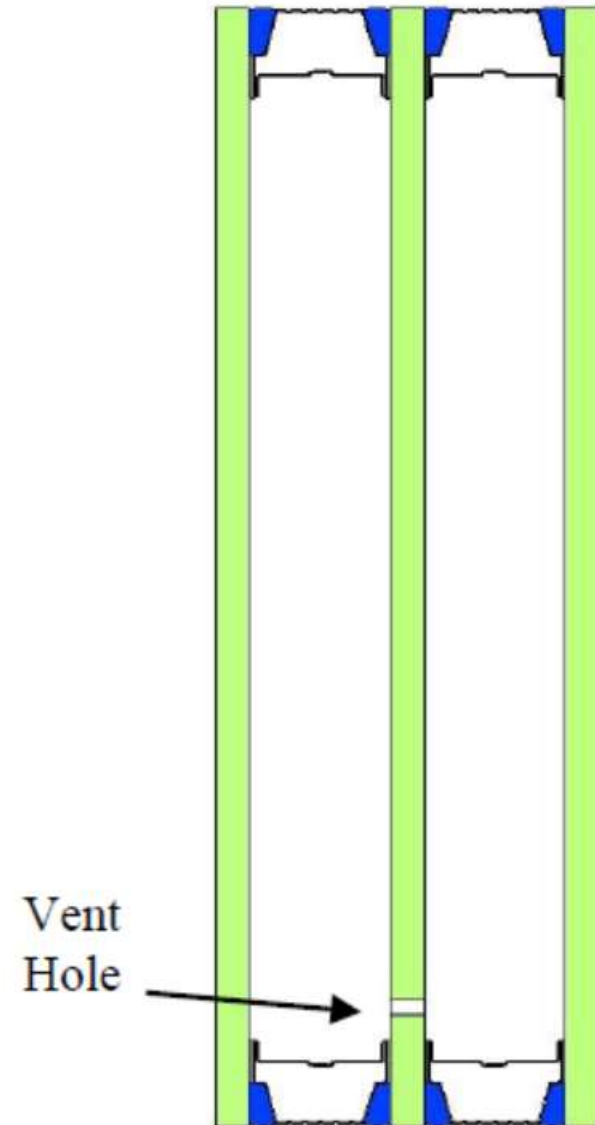
---



- Volume(s) of gas act together
  - (2) 13mm gaps = 26 mm of volume
  - More expansion/contraction
  - Stress on edge seal
  - Depending on glass size/type Cardinal recommends max gap of 13mm
- Distortion due to differential deflections
  - Cardinal recommends pressure equalization
- **Potential for thermal stress breakage**
  - Avoid low-E coating in center pane
  - Use high solar gain low-E on surface 5

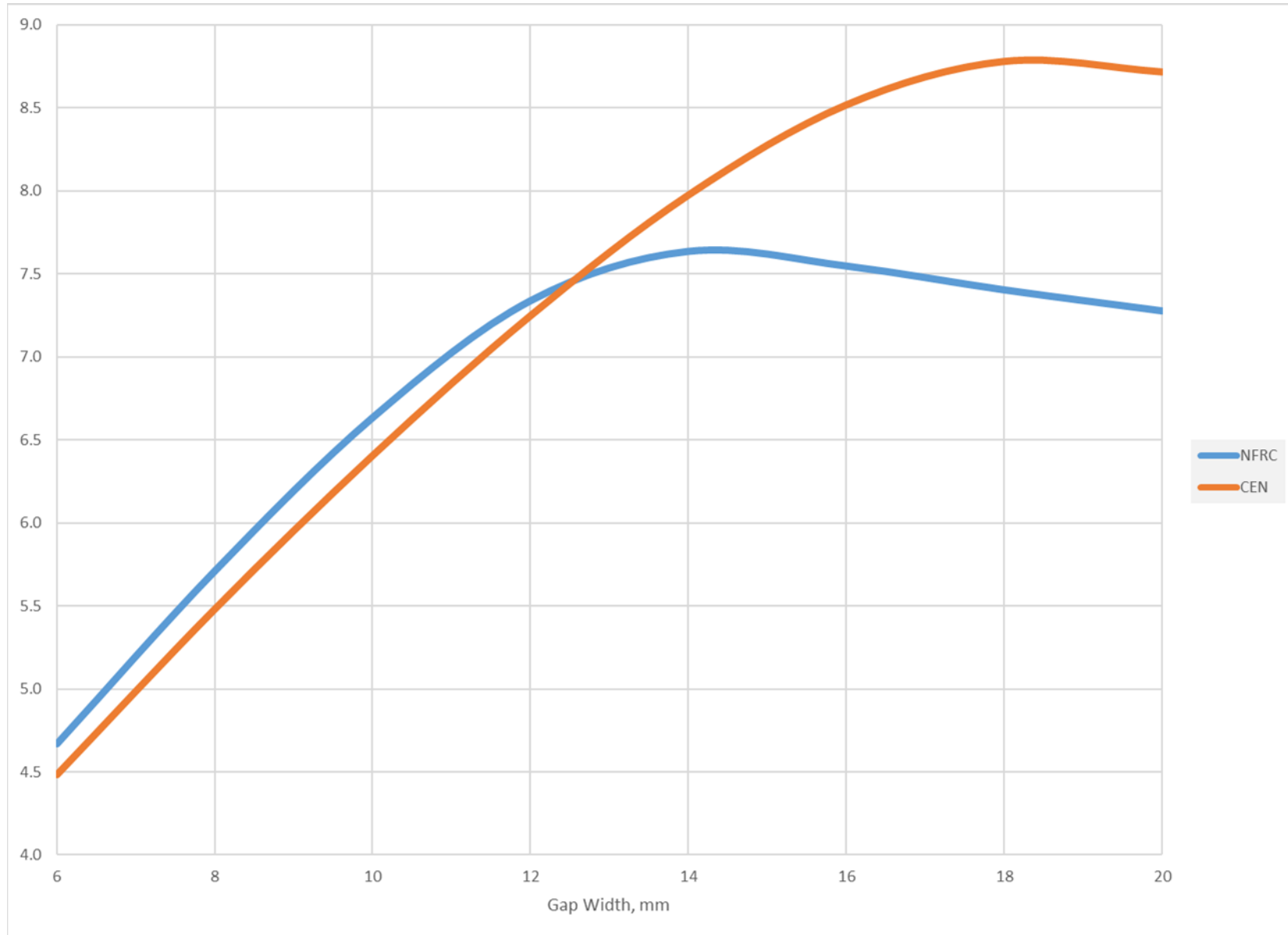
# Low-E Placement/Type

- Due to risk of trapped heat/thermal stress breakage, do not put low-E coating on center pane
- Use high solar gain low-E on surface #5
  - Minimizes thermal stress and potential for color problems
- Select high, medium, low solar gain for surface #2 depending on orientation and building design





# Marketing says R9 Glass!





**Thank you for you attention.**

**Any questions?**